Ministry for the Environment
Manatū Mō Te Taiao

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27 February 2019

18-D-02833

[redacted]
University of Canterbury
[redacted]

Dear [redacted]

Thank you for your email of 19 December 2018, transferred by The Department of Internal Affairs to Ministry for the Environment, requesting the following:

> *I would like to obtain a copy of the business case prepared by ECan for the Minstry for the Environment that describes how improving Te Waihora to national standards would have 'severe social and economic' consequences.*
>
> *The case is referenced in the following Stuff article from August 9, 2018: https://www.stuff.co.nz/environment/95610302/improving-lake-to-national-standard-would-have-severe-social-and-economic-consequences*

Because of the nature of your request, this is being treated as a request for information under the Official Information Act 1982 (the Act).

Please find attached the document *Selwyn Te Waihora zone, Memorandum on the Implications of meeting the National Policy Statement for Freshwater Management objectives for lake environments in Te Waihora.*

<u>Background</u>

This document sets out the estimates of the land use changes and economic costs associated with achieving reductions in nitrogen and phosphorus loads in the Selwyn Te Waihora catchment. Environment Canterbury calculated that the nutrient reductions were needed to meet national bottom lines for lakes set out in the National Policy Statement for Freshwater Management.

National bottom lines for the ecosystem health of lakes are set according to the biophysical needs of the water body. When councils choose the timeframes to achieve those bottom lines, they must consider the social, cultural and economic implications of those choices. If water quality in a water body cannot be improved sufficiently to meet a national bottom line under any feasible scenarios, the water body may be listed in Appendix 4 of the National Policy Statement for Freshwater Management allowing the council to set an objective below the national line for a transitional period. After that period, a new objective must be set to at least meet the national bottom line. If that is not possible, a new transitional period may be provided in the National Policy Statement for Freshwater Management.

Improving water quality over time is consistent with the long term approach for ecological and cultural restoration programme planned for Te Waihora / Lake Ellesmere.

<u>Queries</u>

You have the right to seek an investigation and review by the Ombudsman of this response. Information about how to make a complaint is available at www.ombudsman.parliament.nz or by phoning 0800 802 602.

If you have any further queries please contact the Executive Relations team by email to ministerials@mfe.govt.nz.

M. Workman

Martin Workman
Director, Water

Selwyn Te Waihora zone

Memorandum on the Implications of meeting the National Policy Statement for Freshwater Management objectives for lake environments in Te Waihora

June 2017

Prepared By:

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LWP Client Report Number:

Report Date: March 2017

LWP Project:

Abbreviations

ECan	Environment Canterbury
GMP	Good Management Practice
ICOLL	Intermittently closing and opening lakes/lagoons
LWRP	Canterbury Land and Water Regional Plan
MFE	Ministry for the Environment
MGM	Metrix of Good management
N	Nitrogen
NOF	National Objective Framework
NPS-FM	National Policy Statement for Freshwater Management
P	Phosphorus
PC1	Plan Change 1 to the LWRP
RMA	Resource Management Act 1991
TLI	Trophic Level Index
TN	Total Nitrogen
TP	Total Phosphorus

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Figures and Tables

Executive Summary

In order to achieve the proposed NPS-FM objectives for lakes a 76% reduction in N and a 50% reduction in P loads would be required relative to those envisaged for the LWRP under Plan Change 1 (PC1) for the Selwyn Te Waihora zone.

This business case estimates the land use and economic costs associated with achieving these targets. It uses a combination of information including from the original analysis undertaken for the LWRP PC1, and more up to date information on returns from land uses and the costs of wetland construction to achieve targets.

The land use change analysis projects a very substantial change in land use in the catchment, with virtually no intensive land uses and the catchment dominated by dryland sheep and beef grazing and by forestry or other extensive land uses. This is expected to result in a reduction in operating surplus returns from the catchment in excess of 80% from $348 million to $45 million per annum.

The wetland construction analysis projects capital costs of $373 million to purchase land and construct wetlands of sufficient size to reduce nutrients to low enough amounts. Approximately one third of the cost would be for land purchase, and the remainder for construction of the wetland.

In addition the LWRP envisages a package of other regulatory and non-regulatory measures which has been costed at $120 million in total.

Widespread loss of equity and change in land ownership is likely, and rural communities will experience loss of services and depopulation.

While it is possible that the N target could be achieved with this level of land use change, it is not clear what measures would need to be taken to further reduce the P concentrations in the lake by 50% beyond that en isaged under LWRP PC1 because it already uses any feasibly useful mitigation strategies for P. No specific costings of achieving this target have therefore been undertaken. N.B. it is estimated that P targets would be reached using the constructed wetland analysis.

1 Background

The National Policy Statement for Freshwater Management (NPS-FM) includes an array of objectives (the National Objectives Framework), among which are objectives for lakes. In the 2014 NPS-FM ICOLLs (intermittently closing and opening lakes/lagoons) were partially excluded from the lakes category, but in the latest proposals for changes to the NPS-FM ICOLs will be subject to inclusion in this category. The NPS-FM national bottom lines for lakes are substantially below those included in the current regulations for Te Waihora. The current regulations are the limits for Te Waihora/Lake Ellesmere in Plan Change 1[1] to the Land and Water Regional Plan (LWRP). Environment Canterbury has opposed the inclusion of ICOLLs as freshwater lakes on the basis of the burden placed on the Selwyn community if Te Waihora was managed as a freshwater lake.

Given their concern over the inclusion of ICOLs as "normal" freshwater bodies Environment Canterbury has offered to provide a business case to MFE on what the economic impact of this in the Selwyn-Waihora catchment. The business case details the economic impact on communities of requiring a move from current regulations to the proposed freshwater bottom lines for lakes in the government's consultation document "Clean Water" (February 2017).

PC1 requires a trophic level index (TLI) target of 6.6, whereas the NPS-FM has a national bottom line of a TLI of 5. TLI is based on measures of N, P and chlorophyll a. Because the TLI is a logarithmic scale (i.e. TLI 6 is 10 times higher than TLI 5.), the TLI targets for the lake result in substantially different N and P concentrations. These target concentrations are shown in Table 1 below.

Table 1: Target N and P limits for Te Waihora under LWRP and NPS-FM

Regulation	Total N (mg/l)	Total P (mg/l)	Phytoplankton (Chl-α)
LWRP (PC1)	3.4	0.1	74
NPS-FM NOF	0.80	0.05	12
Reduction LWRP to NPS-FM	76%	50%	84%

Environment Canterbury is concerned that the measure required to attempt to achieve these very substantial reduction in N and P concentrations would have severe social and economic impacts on communities in the lake catchment. Because the scale of the changes is so large, the modifications required lie well outside the parameters of any real data or modelled assessments of nutrient reductions in New Zealand. It is difficult therefore to predict what may occur under such a scenario. This analysis therefore aims to provide a broad understanding of the potential impacts rather than a definitive estimate of the likely costs.

[1] Table 11(b) Freshwater Outcomes for Selwyn Te Waihora Sub-region Lakes (Te Waihora/Lake Ellesmere TLI 6.6 (mid lake) and 6 (lake margins)

2 Method

The analysis undertaken here uses available information from a range of sources. The analysis uses two methods to assess the possible impact of achieving National Bottom Lines for Total Nitrogen and Total Phosphorus. It is assumed that by achieving the TN and TP National Bottom Lines the chlorophyll a National Bottom Line will also be achieved.

- The first analysis assumes that the % reduction required in the lake nutrients is achieved through an equivalent reduction in losses from land uses in the catchment. This follows the methodology used in Plan Change 1 of the Canterbury Land and Water Regional Plan. This method is referred to in this document as the “land use change analysis”.
    - o The PC1 land use is based on the assumptions in the economic analysis of the Selwyn Te Waihora (S-W) zone solutions pack (Harris, 2014). These were apportioned according to the spread of current land use as provided for the economic analysis of scenario 3. The land use assumptions for Solutions Package 2 are shown in Table 2.
- The second analysis assumes that the % reduction required in lake nutrients is achieved through constructing wetlands at the bottom of the catchment which strip enough incoming nutrients to achieve lake limits. This method is referred to in this document as the “constructed wetland analysis”.

2.1 Land use change analysis

The analysis undertaken for PC1 was not able to be used directly because the lowest trophic state for Te Waihora investigated was a Trophic Level Index (TLI) of 6, where the NOF proposes bottom lines equivalent to a TLI of 5. Specifically:

Table 2: Land use by soil type for Solution Package 2 (TLI 6.6)

	Area by soil type (ha)				**Total**
Land use	**Very light**	**Light**	**Moderate**	**Heavy**	
Arable irrigated	1,076	5,626	7,294	12,452	**26,447**
Arable dry	408	2,280	3,481	3,195	**9,364**
Dairy	9,973	29,387	5,756	12,341	**57,457**
Dairy support irrigated	2,066	1,976	4,580	5,972	**14,595**
Dairy support dryland	4,522	3,832	2,161	5,832	**16,347**
Forestry	2,860	6,764	1,302	2,075	**13,000**
Intensive irrigated sheep and beef and deer	4,960	14,143	6,591	8,826	**34,520**
Intensive dryland sheep and beef	9,333	18,177	11,868	12,077	**51,455**
Permanent Horticulture	61	218	180	299	**757**
Vegetables	22	170	147	353	**692**
Lifestyle, pigs etc.	1,604	6,108	3,036	5,130	**15,878**
Other unproductive	16,164	6,753	3,810	5,058	**31,785**
Total	**53,047**	**95,433**	**50,205**	**73,612**	**272,297**

Farm returns are as included in the original PC1 analysis. These were compared with more recent data from other zone processes in Canterbury and generally have higher returns for dairy and lower returns for sheep and beef than would currently be used. However the differences are small in the context of the overall potential errors in this analysis.

Analysis losses of N from land use and soil type as used for the economic analysis of the Selwyn Te Waihora (S-W) zone Solutions Pack 2. Note that these are based on the original ‘lookup table’ based assessment of nutrient losses, not the more recent MGM approach. The definition of GMP used for the MGM is more stringent than that used for the lookup table, but this in turn is offset by using the mitigation potential from the original analysis which is also greater than is likely to be experienced using the MGM as a baseline. Note also that the costs of mitigation would currently be considerably higher than was estimated for the PC1 process, but these higher costs have not been included in this analysis because of difficulties in maintaining continuity with the original assumptions used in the analysis generated for PC1. The N losses by land use type, mitigation potential and mitigation costs are shown in Table 3 below.

Table 3: N losses mitigation and operating profit assumptions by soil type and land use,

	N loss by soil type (kgN/ha/year)						
Land use	**Very light**	**Light**	**Moderate**	**Heavy**	**Mitigation achievable (% reduction from GMP)**	**Cost of mitigation (%operating profit)**	**Operating profit before mitigation ($/ha/annum)**
Arable irrigated	22.9	21.1	18.1	5.7	0.30	10%	$1,079
Arable dryland	22.4	22.6	21.6	4.0	0.35	10%	$450
Dairy	45.9	29.8	17.6	10.1	0.45	12%	$2,858
Dairy support irrigated	57.3	37.2	21.	12.6	0.25	75%	$828
Dairy support dryland	24.2	19.8	11.9	7.0	0.25	75%	$433
Forestry	1.0	1.3	1.0	0.6	0	12%	$100
Intensive irrigated Sheep and beef and deer	36.5	23.7	14.0	8.1	0.1	12%	$1,216
Intensive dryland sheep and beef	14.0	11.5	6.9	4.0	0	0%	$353
Permanent Horticulture	8.2	11.6	7.1	7.8	0.1	10%	$6,782
Vegetables	26.4	13.4	8.8	6.3	0.2	10%	$0
Lifestyle, pigs etc.	21.7	19.0	10.3	13.1	0.1	5%	$353
Other unproductive	0.0	0.0	0.0	0.0	0		$0

The impact of the lower TLI target would depend on the way in which the cuts were required to be implemented. For example if all land uses were required to reduce to 22% of their current loss, only forestry and small areas of sheep and beef would remain. On the other had if full trading were allowed it is possible that there would be the retention of small areas of dairying and other intensive land uses on heavier soils. For the purposes of this business case a simple an algorithmic approach is used to define the land use change required to achieving the N criteria for the NOF target of TLI 5. This involved removing intensive land uses from lighter (leakier) soils and replacing them with dryland sheep and beef, and then with forestry until the targeted reduction is achieved. No change is made to horticulture and vegetable production, lifestyle and non-productive land. This land use set should be viewed as indicative of the potential implications, and in practice the scale of the change required is so substantial that the method chosen would have little impact on the final result.

2.2 Constructed wetland analysis

Tanner et al. (2015) analysed nutrient inputs into Te Waihora and then modelled the amount of wetland required in each of the major tributaries to achieve Total Nitrogen reductions of 20% and 40%. The modelling was based on relationships derived from measured reductions in nutrients at other wetland sites. Using seasonal mean flows and nutrient concentrations the modelling showed that a total of 593 ha or 1,782 ha of wetland would be required to reduce the annual nitrogen loads in all the major surface inflows to the lake by 20% and 40% respectively (Tanner et al., 2015).

Tanner et al. (2015) state that "such proportional reductions in N load would also be likely to be maintained if, as forecast, inflowing N concentrations increase in the future". The relationship between wetland area and nutrient reduction is non-linear which "reflects the diminishing returns achievable as nutrient concentrations decline during passage through a wetland system" (Tanner et al., 2015).

The results of Table 5.1 in Tanner et al. (2015) have been extrapolated into the non-linear relationship shown in figure 1. Using this relationship it can be seen that to achieve a Total Nitrogen reduction of 76% in the tributaries would require 5,424 ha of wetland. Using the same data from Table 5.1 in Tanner et al. (2015) suggests that 5,424 ha of wetland would also achieve an approximate 72% reduction in Total Phosphorus (i.e. well over the amount required to achieve the NPS National Bottom Line for TP).

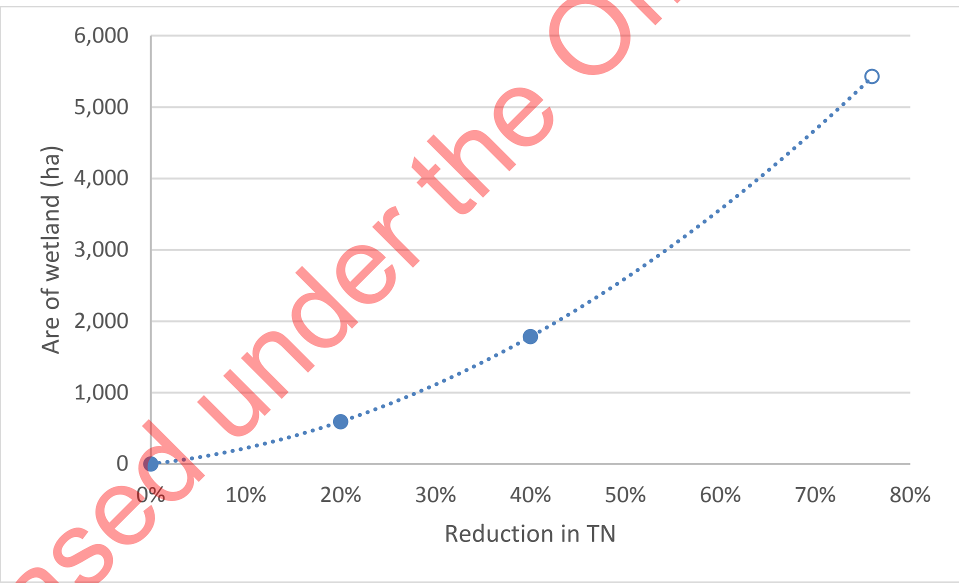

Figure 1: Land use under PC1 (Solutions Package 2) and NPS-FM targets for Selwyn Te Waihora zone (ha)

The method used in this estimate is very rough and consequently the area of land required in wetland was rounded up to 5,500ha.

The cost of purchasing 5,500 ha of land near to the lake margin was then estimated using information from Government Valuations. While in theory wetlands could be constructed anywhere across the catchment to add up to 5,500 ha, the analysis of Tanner et al. (2015) was based on surface inflows to the lake which are only available in the lower parts of the catchment (i.e. groundwater fed streams). It is also most efficient from a nutrient stripping point of view to have wetlands near the bottom of the catchment where concentrations are highest. Therefore it has been assumed that the land to be used for wetlands is near the lake margin. The land available for wetlands near the lake margins is a mixture of marginal land used for rough grazing and highly productive farmland. There is not enough marginal land near the lake margin to make up the full 5,500 ha so we assumed that 25% of the land would be from marginal land and 75% from fully productive land.

The cost of constructing wetland near to Te Waihora was estimated based on recent restoration work near Taumutu and costings done for the recent Freshwater Improvement Fund bid constructing wetland at Te Ahuriri (near to Te Waihora). Constructing wetland from scratch is expensive, as much as $100,000 per hectare when proper design, earthworks, planting and maintenance is fully included. Given the scale of wetland construction required here it was assumed that scaling would bring the costs down considerably. Therefore it was assumed the cost of wetland construction is approximately $50,000 per hectare and it would be cheaper again on marginal land given the common occurrence of this land being wet for part of the year already.

3 Results

3.1 Land use change analysis

Land use required to achieve TN target

The land use in the catchment will have to alter dramatically to achieve the TLI target of 5, because the N reduction to 22% of current is not achievable either by mitigation of current land uses, nor by reducing intensity of current intensive production systems. In essence only dryland sheep and beef and forestry can be utilised as a land use in the catchment. It should be noted though that even forestry may not be possible because the reduction in aquifer recharge may result in higher concentrations of nutrients in lowland streams and lowered stream flows, which breaches other desired outcomes in the catchment. In the original Scenario 3 analysis to achieve a TLI of 6, forestry had to be substituted with extensive sheep and beef in order for the other catchment outcomes to be achieved (i.e. to maintain desired flows in lowland streams). It should also be noted that the lack of irrigation in the catchment may also impact on stream flows because of the higher land surface recharge from the irrigated systems.

Table 4: Land use required to achieve TLI 5 (N losses 24% of PC1 Solutions Package 2)

	Area by Soil type (ha)				
	Very light	**Light**	**Medium**	**High**	**Total**
Arable irrigated					**-**
Arable dryland					**-**
Dairy					**-**
Dairy support irrigated					**-**
Dairy support dryland					**-**
Forestry	35,197	82,185	5,031	2,075	**124 488**
Intensive irrigated Sheep and beef and deer				-	**-**
Intensive dryland sheep and beef	-	-	38,000	60,697	**98,697**
Permanent Horticulture	61	218	180	299	**757**
Vegetables	22	170	147	353	**692**
Lifestyle, pigs etc.	1,604	6,108	3,036	5,130	**15,878**
Other unproductive	16,164	6,753	3,810	5,058	**31,785**
Total	**53,047**	**95,433**	**50 205**	**73,612**	**272,297**

Land use change of this scale would have very substantial implications for the catchment. There would be effectively no irrigation or intensive land use in the catchment, and forestry or extensive grazing would dominate the landscape. Such large scale effective retirement of intensive land has not been experienced in New Zealand on any scale, and the implications would be far reaching. There would be significant changes in the social structure of the catchment, with the forestry or extensive grazing resulting in fewer farms and reduction in employment, losses of economic value in the land, significant loss in equity, and depending on the time scale bankruptcy for those with debt that could not be managed through the transition. The large scale reliance on two industries (forestry and dryland sheep/beef) inevitably leads to a less resilient local economy vulnerable to swings in only three commodity prices.

It is also worth noting that the effect of the land use change would not be seen for many decades due to the lag times for nutrients already in the system to move through groundwater and those already entrained within lake sediment being released.

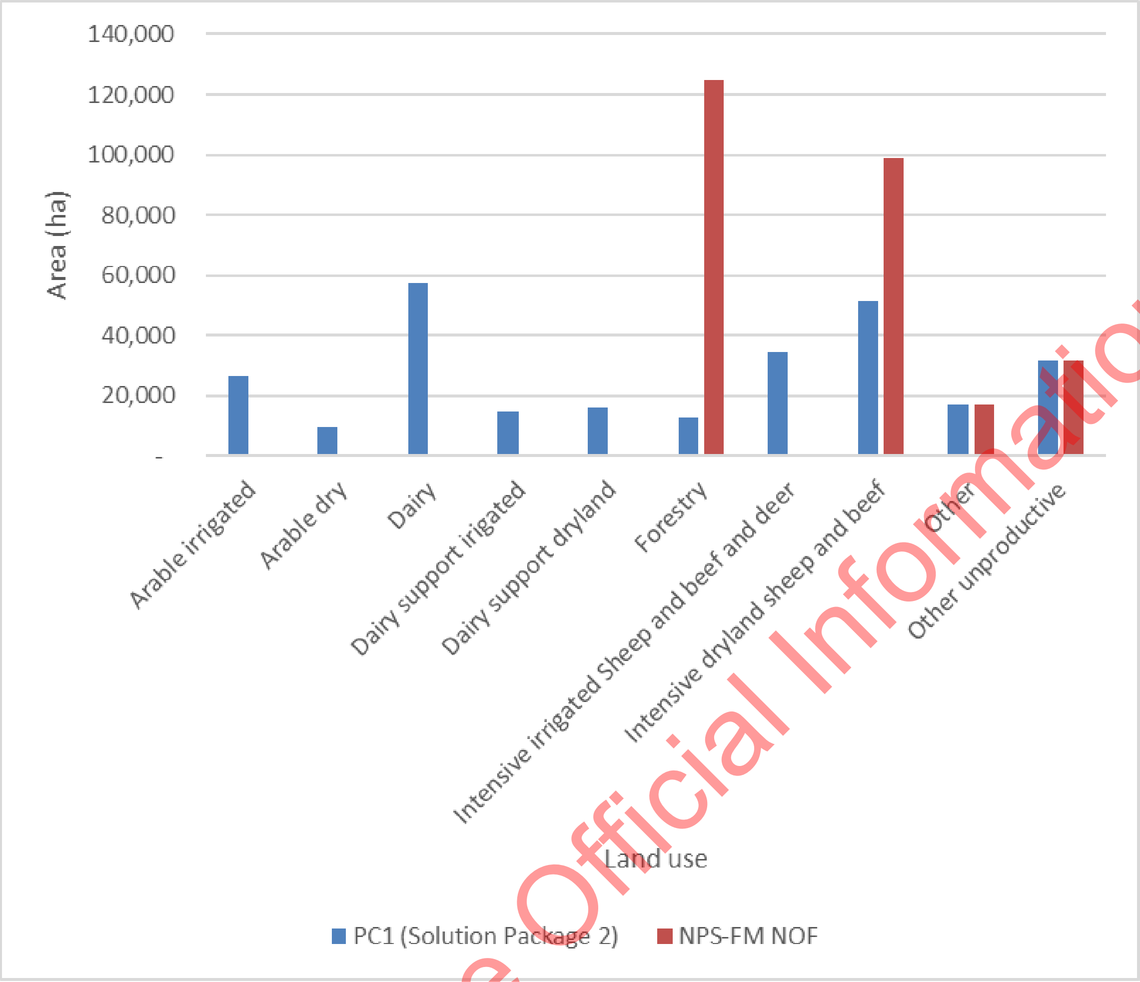

Figure 2 Land use under PC1 (Solutions Package 2) and NPS-FM targets for Selwyn Te Waihora zone (ha)

Economic costs to achieve TN target

The implementation of the NPS-FM would result in very substantial reductions in returns from land use in the catchment. Operating surplus from most intensive land uses would reduce to $0 and would be replaced by less intensive land use and forestry with much lower returns. The overall reduction is in the order of 80% relative to PC1 of the LWRP. These results will slightly overstate the impact because the costs of mitigation for PC1 have not been included. It should be noted in this context that PC1 requires a reduction in the order of 12.5% in N losses from land uses in the catchment, which was considered achievable without major land use change when spread differentially across land uses.

As noted above this reduction in economic activity will cause very substantial impacts to businesses and individuals in the catchment. Land value would decrease, and loss of equity would be substantial. Change of ownership and amalgamation of land would be inevitable. Rural communities would lose services and support businesses, and depopulation is highly likely to areas further from Christchurch and is likely to impact upon Christchurch itself.

Table 5: Operating surplus after mitigation and land use change ($million/annum, excludes capital costs of changes)

	Operating surplus ($million/annum)		
Land use (ha)	**PC1 (Solution Package 2)**	**NPS-FM NOF**	**Reduction in operating surplus (%)**
Arable irrigated	$33.4	$0	100%
Arable dry	$11.8	$0	100%
Dairy	$229.2	$0	100%
Dairy Support irrigated	$10.8	$0	100%
Dairy support dryland	$8.9	$0	100%
Forestry	$2.6	$11.0	-319%
Intensive irrigated Sheep and beef and deer	$30.2	$0	100%
Intensive dryland sheep and beef	$14.5	$27.7	-92%
Other	$6.7	$6.4	5%
Other unproductive	$0	$0	0%
Total	**$348.3**	**$45.1**	**87%**

3.2 Constructed wetland analysis

The estimated costs of wetland construction to achieve TN reductions is shown in table 6. This is a very rough estimate which suggests around $373 million dollars of capital cost, of which approximately one third is for land purchase. Land purchase costs may be slightly cheaper than estimated as some of the marginal land is already owned by government agencies such as the Department of Conservation and Environment Canterbury but if this land were available for "free" it would only reduce costs by up to $10M. However the costs of purchase of productive land may also be higher if significant proportions of the land purchased had non-recoverable installed infrastructure such as irrigation systems, cowsheds, barns etc. that would need to be included in the purchase price.

Table 6: Estimated costs for wetland creation in land near Te Waihora

Land type	Area of land (ha)	Value per ha ($)	Wetland conversion cost per ha	Total cost (millions $)
Marginal and	1,375	$7,500	$40,000	65.3
Fully productive land	4,125	$24,500	$50,000	307.3
Total	**5,500**	**$20,250**		**372.6**

3.3 Costs of other regulatory and non-regulatory interventions

The LWRP envisages a substantial package of works that are both regulatory and non-regulatory in order to achieve the PC1 targets. These are shown in Appendix A and were costed at $120 million at the time of notification of PC1. The costs of these will be borne by the council and landholders, with the largest part in the cost in fencing and riparian planting for streams, drains and the lake.

The costs of achieving the 50% required reduction in P losses have not been costed directly. The land use change envisaged to achieve the NPS-FM N targets would go some way to ameliorating the impact of losses caused by land use activity. However to move beyond this if required there are not many other measures to mitigate the losses of P that could be considered that have not already been included in PC1. Furthermore because there is substantial P reservoir in the Waihora lakebed sediment, and because of the shallow nature of the lake and highly turbid conditions, this P is constantly re-suspended. While PC1 proposes measures to address this, it is unclear what further acceptable measures that could be taken to achieve a halving of P concentrations beyond the LWRP PC1 targets.

3.4 Caveats

The results provided here should be viewed as indicative and broad brush only, and there are a number of considerations that should be taken into account when considering the results:

- The N loss estimates are based on the original lookup table for the PC1 analysis[2]. More up to date estimates of losses by land use and soil type may produce a different outcome, although it is unlikely the overall conclusion would change significantly.
- The analysis uses information on land use returns and mitigation costs that are not current and are those used for the original PC1 analysis. However when considering relative differences in economic outcomes any errors caused by the use of older data are likely to be within the margins of error for the analysis.
- The land use returns do not include cost of capital. While much of the existing irrigation and intensive agriculture infrastructure could not be recovered with nature of the land use change to achieve the NOF targets, there would be some gains from the sale of livestock and plant that would increase the operating profit after tax for the NPSFM-NOF scenario relative to that presented here.
- The modelling approach to estimating the change in land use is relatively crude, but because the reduction in nutrients required are so significant in the context of overall land use in the catchment, any modelling approach adopted could only make marginal differences to the results.
- The estimation of the required changes in nutrient losses from land assume that attenuation of N between the land and receiving environment will be unchanged and that changes in modified and intensive land based losses will result in a proportionate reduction in concentrations in Te Waihora. However with such significant changes required the natural losses from non-productive land uses and losses from extensive sheep and beef in the upper parts of the catchment will become much more significant in terms of the total load. This would mean that the reductions required from modified intensive land uses could be more significant than has been assumed here.

[2] The more recent MGM estimates of N loss tend to be higher than the earlier lookup table figures, It is not clear how this would affect the modelling of lake TLI implications (see Lillburne, L. 2016. Recalculated Nitrogen loads for Selwyn. Unpublished draft memorandum prepared for Carl Hanson, Environment Canterbury. 15 June 2016.

- The scale of the land use changes in the catchment would have other impacts that are not able to be considered here, particularly in relation to the water balance in lowland streams from removing irrigation based on main stem river water, and inclusion of forestry with higher water interception rates than pasture.
- The cost of land purchase is based on government valuation for land only (i.e. no capital improvements) and the wetland construction costs are very rough estimates.

5 References

Harris S (2014) Technical Report to support water quality and water quantity limit setting process in Selwyn-Waihora Catchment. Predicting consequences of future scenarios: Economic Impact. Environment Canterbury Report R14/12. **http://files.ecan.govt.nz/public/lwrp/variation1/tech-report-sw-economic-impact-assessment.pdf**

Tanner CC, Sukias J, de Winton M, Larned S, Sutherland D, Hughes A (2015) Wetland Nutrient Attenuation Assessment for Inflows to Te Waihora / Lake Ellesmere. NIWA Client Report Number HAM2015-040, prepared for Whakaora Te Waihora.

6 Appendices

Appendix A Costings for other interventions and mitigation costs in the catchment under LWRP

Area	Item	Subitem	Quantity	Unit	Cost/unit	Capital cost	Operating cost	Existing WTW and council	Comment
Catchment	Managed Aquifer Recharge	Infiltration basin	5	ha	$50,000	$250,000			Estimate for 5 infiltration basins of 1 ha each (Unsourced nominal allowance)
		Land	5	ha	$30,000	$150,000			Standard cost for land based on CV for intensive sheep and beef. Additional 50% allowed for infrastructure and other value.'
	Augmentation	Structures	30	bores	$20,000	$600,000	$100,000		10 bores @$20,000/bore. OPEX from SDC for races. This delivers 1cumec, and additional 2 cumecs would add a further 20 bores. Potential for some cost for accessing water from Lake Coleridge at low flow times, but it is more likely that augmentation would be associated with spare system capacity. Source Brett Painter, pers.comm.
Lake	Control structure		1	unit	$5,000,000				Source: Ned Norton, NIWA pers.comm. Operational costs too speculative too identify at this stage.
	P inactivation		1	unit	$5,000,000				Source: Ned Norton, NIWA pers.comm. Operational costs too speculative too identify at this stage.
	Buffer around lake	Fencing	100	km	$9,000	$900,000		$1,215,000	Allows for 7 wire fence, but no gates, corners etc. (Source: Lincoln University Farm Budget Manual 2011)
		Planting and initial maintenance	200	ha	$47,430	$9,486,000			20m buffer, with 4500 plants/ha at 6.54/plant plus $4/plant for maintenance over 2 years. (Source: Waihora Ellesmere Trust Riparian Flier, 2011. http://www.wet.org.nz/wp-content/uploads/2011/03/2011-March-riparian-restoration-flyer.pdf)
		Ongoing maintenance	200	ha	$101		$20,200		Weed and pest, repairs and maintenance, and vehicle costs from a Canterbury sheep farm budget per ha costs (Source: MPI Farm Monitoring Report, 2012)
		Land	200	ha	$30,000	$6,000,000		$6,000,000	Standard cost for land based on CV for intensive sheep and beef (Source: Quotable Value NZ, average of identifiable properties in lake vicinity)
	11 lakeshore sites					$200,000		$200,000	WTW project (source WTW)

Area	Item	Subitem	Quantity	Unit	Cost/unit	Capital cost	Operating cost	Existing WTW and council	Comment
	Restoration of macrophytes					$685,000		$685,000	Cost unknown until trials completed (Source WTW) Operational costs too speculative too identify at this stage.
	Floating wetlands		72963	m2	$233	$17,024,691		$17,024,691	Cost ex 3000m2 floating wetland created for Lake Rotoehu, scaled up for lake surface area. http://www.wetlandtrust.org.nz/documents/spring2011.pdf. Operational costs too speculative too identify at this stage.
	Trial establishment of small islands					$325,000		$325,000	Costs unknown until trials completed (source WTW). Operational costs too speculative too identify at this stage.
Stream	**Riparian planting**	**Fencing**	1500		$9,000	$13,500,000			Allows for 7 wire fence, but no gates, corners etc. (Source: Lincoln University Farm Budget Manual 2011)
		Planting	375		$47,430	$17,786,250		$1,729,350	5 m one side, with 4500 plants/ha at 6.54/plant plus $4/plant for maintenance over 2 years. (Source: Waihora Ellesmere Trust Riparian Flier, 2011. http://www.wet.org.nz/wp-content/uploads/2011/03/2011-March-riparian-restoration-flyer.pdf)
		Maintenance	375		$101		$37,875		Weed and pest, repairs and maintenance, and vehicle costs from a Canterbury sheep farm budget per ha costs (Source: MPI Farm Monitoring Report, 2012)
		Land	375		$30,000	$11,250,000			Standard cost for land based on CV for intensive sheep and beef (Source: Quotable Value NZ, average of identifiable properties in lake vicinity)
	Improved drainage management	**Mechanical clearance of sediment**				$1,200,000			$10/m which allows for 150/hour (3 labour units plus additional equipment and disposal costs estimated) doing 15m/hour. Assumes that removed sediment can be dumped on adjacent land. (Source Mark Taylor, AEL, pers.comm.)

Area	Item	Subitem	Quantity	Unit	Cost/unit	Capital cost	Operating cost	Existing WTW and council	Comment
		Active management of macrophyte growth	0	km requiring macrophyte removal	$2,325		$0	$0	Allows for annual macrophyte removal. Without shading this is likely to be at least twice annually. Costs are midway between boat and clearance. Note feasibility issues of removing weeds with riparian plantings in slow moving streams. Assumes 30% already covered by existing council stream clearance work
	Drainage network project	**Fencing**	1000	km	$9,000	$9,000,000			Allows for 7 wire fence, but no gates, corners etc. (Source Lincoln University Farm Budget Manual, 2011)
		Riparian planting	300	ha	$47,430	$14,229,000		$639,000	3m one side of drain with 4500 plants/ha at 6.54/plant plus $4/plant for maintenance over 2 years. (Source: Waihora Ellesmere Trust Riparian Flier, 2011. http://www.wet.org.nz/wp-content/uploads/2011/03/2011-March-riparian-restoration-flyer.pdf)
		Maintenance	300	ha	$101		$30,300		Weed and pest, repairs and maintenance, and vehicle costs from a Canterbury sheep farm budget per ha costs (Source: MPI Farm Monitoring Report, 2012)
		Land	300	ha	$30,000	$9,000,000			Standard cost for land based on CV for intensive sheep and beef (Source: Quotable Value NZ, average of identifiable properties in lake vicinity)
		Restoration plans	50	plans	$1,500	$75,000			50 at 1.5 days each (unsourced nominal allowance)
		Training, co-ordination	2	days	$1,000			$2,000	2 days (unsourced nominal allowance)
	Retirement of wet land around springhead areas and removal of stock access	**Land**	90	ha	$30,000	$2,700,000		9 sites of 10 ha	
		Fencing	28	km	$9,000	$256,144		$90,000	Assume each site a square of 100m sides. Fencing costs as above

Area	Item	Subitem	Quantity	Unit	Cost/unit	Capital cost	Operating cost	Existing WTW and council	Comment
		Planting	90	ha	$47,430	$4,268,700			4500 plan s/ha at 6.54/plant plus $4/plant for maintenance over 2 years. (Source: Waihora Ellesmere Trust Riparian Flier, 2011. http://www.wet.org.nz/wp-content/uploads/2011/03/2011-March-riparian-restoration-flyer.pdf)
		Ongoing maintenance	90	ha	$101		$9,090		Weed and pest, repairs and maintenance, and vehicle costs from a Canterbury sheep farm budget per ha costs (Source: MPI Farm Monitoring Report, 2012)
		Wetland study				100000			(Unsourced nominal allowance)
On farm	**Extension programme**	**Workshops/field days**	140	Field day/workshop	$1,500	$210,000			Allow 20 farmers per workshop, 2 workshops/field days each. (Unsourced nominal allowance)
		Field trials	5	Trial	$20,000	$100,000			Source AgResearch
					$200,000				
Social and cultural	**Social benefits**	**Annual Monitoring**	0.2	FTE	$200,000		$40,000		(Source: Nick Taylor, Taylor Baines, pers.comm.)
		5 yearly survey	0.04	FTE annual cost	$200,000		$8,000		(Source: Nick Taylor, Taylor Baines, pers.comm.)
		Community worker	1	FTE	$200,000		$200,000		(Source: Nick Taylor, Taylor Baines, pers.comm.)
		Cultural facilitator	0.5	FTE	$200,000		$100,000		(Source: Nick Taylor, Taylor Baines, pers.comm.)
		Enhanced water based recreation	0.2	FTE	$200,000		$40,000		(Source: Nick Taylor, Taylor Baines, pers.comm.)
		Communications	1	Comms package	$50,000		$50,000		(Source: Nick Taylor, Taylor Baines, pers.comm.)
Regulatory	**Nutrient Discharge Allowance**	**Farm plans setup**	1200		$2,000	$2,400,000			(Source Claire Mulcock, Mulgor Consulting)

Area	Item	Subitem	Quantity	Unit	Cost/unit	Capital cost	Operating cost	Existing WTW and council	Comment
		Farm plans turnover	180		$2,000		$360,000		Assumes 15% of farms turnover or change farm systems annually. (Source Claire Mulcock, Mulgor Consu ting)
		Farm plans auditing	480		$500		$240,000		C rrent irrigation scheme auditing is $400/farm. (Source Claire Mulcock, Mulgor Consulting)
		Nutrient consents	116	Consents	$2,000		$232,300		Assume 5% of farms cannot meet targets, require consents. (Unsourced nominal allowance)
	Water quantity trading	**Transaction costs irrigation consents transfer**	11	consents	$2,000		$22,000		Assumes 11 consents transfer annually (historic rate of transfer) (Unsourced nominal allowance)
			0.005	Irrigated CFS	$300,348,086		$750,870		Assumes nominally 0.5% of irrigated area lost annually as a result of transfer provision (historically 11 transfers/annum out of 2230 consents total). Figure equal to 50% of aggregate CFS from that land.
Total						**$121,695 786**	**$2,240,635**	**$27,910,041**	